Appendix F - SDNM Complex Livestock Use Probability Map

Introduction

Understanding the distribution of livestock grazing across rangelands is important when making rangeland management decisions. Range managers often rely on the percent utilization of key forage species to determine livestock use levels and potential impacts livestock grazing has on the local resources. However, this information is sometimes unavailable due to legal and financial constraints of the range or operation in question. Livestock use probability maps can assist range manager decision making in the absence of current or multiple years of utilization data. This paper describes the development of a livestock use probability map for complex of allotments centered around the Sonoran Desert National Monument (SDNM) named the SDNM Complex and how it can be used to determine if livestock grazing is the causal factor for the non-achievement of land health standards.

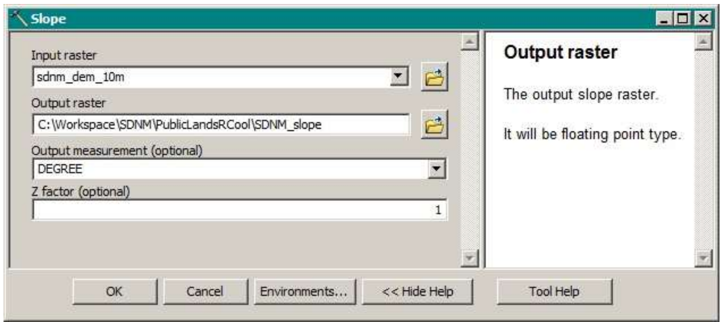
Methods

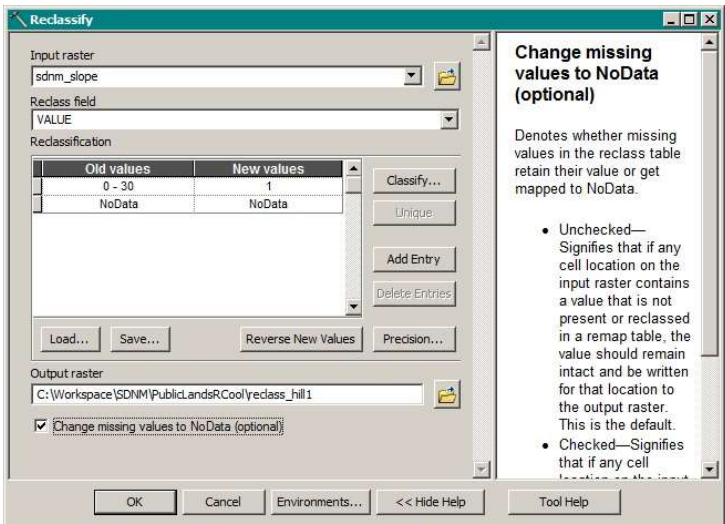
ESRI's geographic information systems (GIS) software ArcMap 10.4.1 and its affiliated data processing tools were used for this project. Livestock use probability maps are developed using multiple data sets representing geographic variables that may influence livestock use across the landscape. The data used for the SDNM Complex and their sources are listed in Table 1.

Layer	Source	Data Type
Digital Elevation Model (DEM) 10m	USGS	Raster
Slope 10m (derived from DEM)	USGS	Raster
Impassable Terrain (derived from DEM)	USGS	Vector – Polygon
Fencing	BLM	Vector – Polyline
Livestock Water Locations	BLM	Vector – Points (weighted)

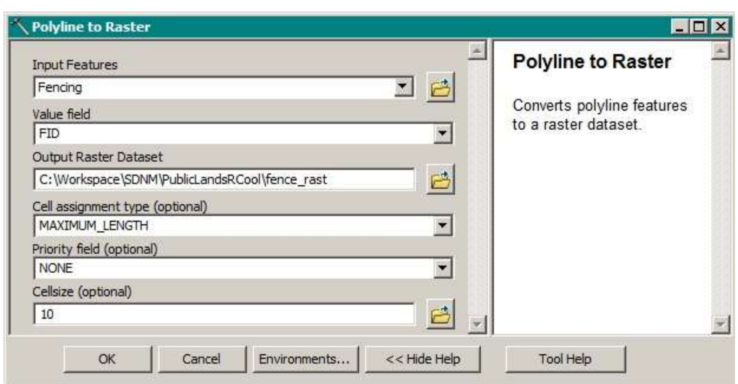
Table 1. SDNM Complex geographic variables

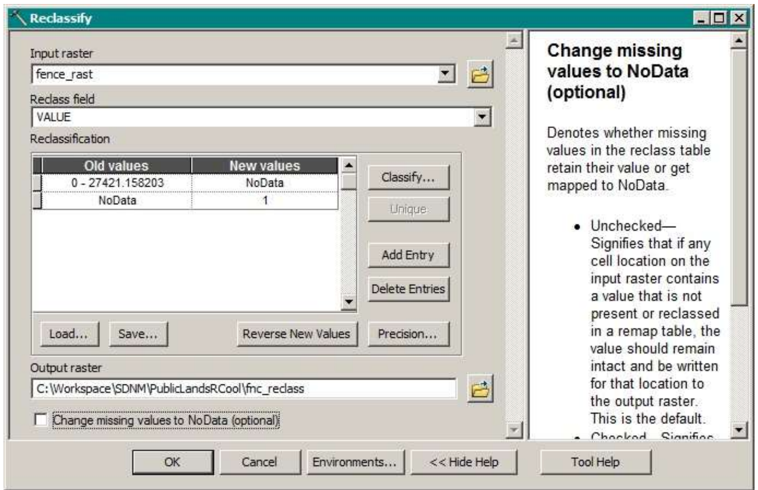
Layers representing slope and barriers, terrain and fencing, were developed to inform the cost surface of slope gradients and areas impassable by livestock. A Digital Elevation Model (DEM) of 10m resolution was used to develop two variables: slope and impassable terrain. Slope was simply derived from the 10m DEM using the "Slope" tool in the Spatial Analyst's Surface tool box. The impassable terrain surface was derived from the resulting slope raster through the reclassification of cells below 30% slope to values of 1, and cells above 30% slope to "NoData" where "NoData" equals impassable areas. A similar approach was used for fencing.

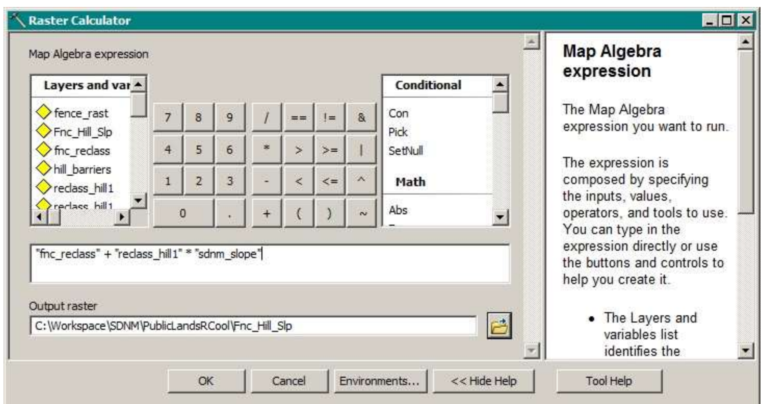




Fence lines were mapped over aerial imagery as polylines with the assistance of ground confirmation, local knowledge, and range improvement project files. Fence polylines were converted to a raster and reclassified where “values” or presence of fence equaled “NoData” and “NoData” equaled 1. “NoData” was used for the same purpose as the impassable terrain layer where cells with “NoData” are equivalent to impassable barriers. ArcMap’s raster calculator was used to combine the slope, terrain, and fencing raster layers into one cost surface.

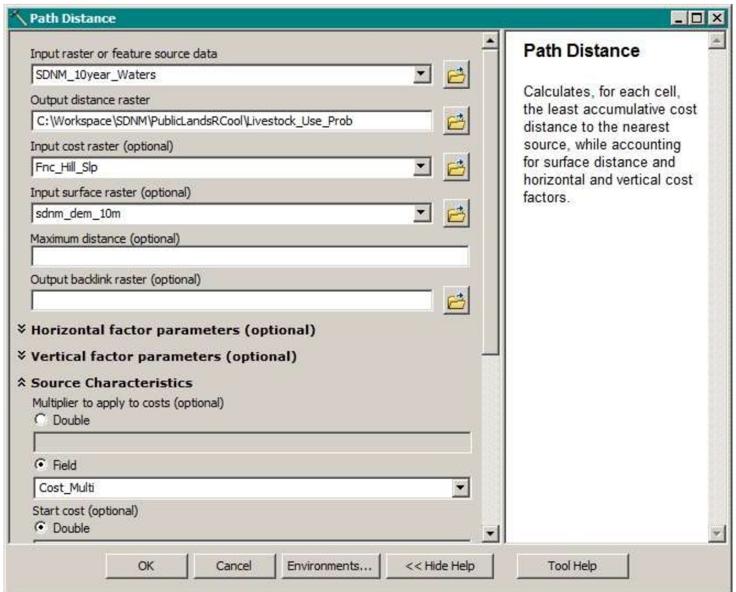


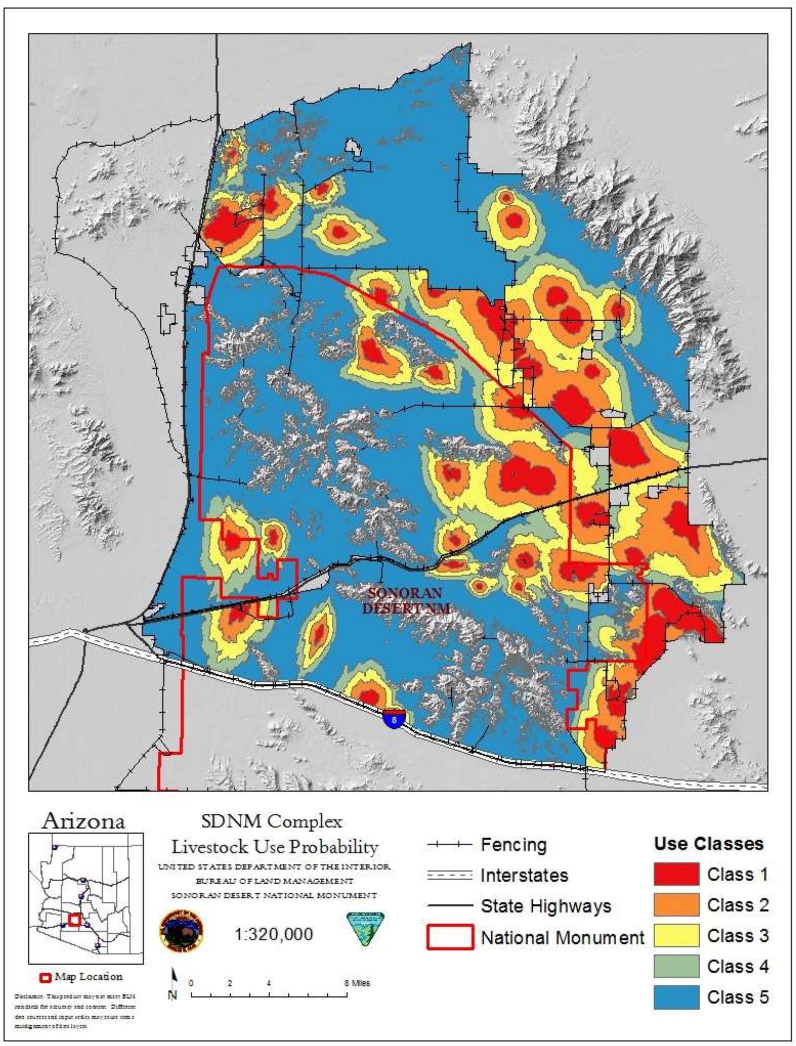




Livestock water locations were mapped over aerial imagery, as points, with the assistance of range improvement project files, field investigations, and local knowledge. To provide a recent representation of livestock use on the SDNM complex, only watering points used by livestock in the past 10 years were included in the data set. The remaining points were then weighted in the attribute table by their reliability. Weighting increases the cost to move away from a point based on its assigned multiplier. For this project, wells retained a weight of 1 and dirt reservoirs were weighted between 1 and 1.99 where 1 equates to 100% reliability and 1.99 equates to 1% reliability. Dirt reservoir reliability was determined by assessing more than ten years of aerial and satellite imagery as well as range improvement inspection reports where a simple “wet/dry” count was made and converted into the percentage of years the reservoir was “wet”.

The Path Distance Tool under the Spatial Analyst Tools was used to produce the final cost surface in relation to livestock use probability on the SDNM Complex. The resulting raster was classified to into 5 classes equating to “costs” (distance) to travel away from livestock watering points at half mile increments.


Path Distance
Input raster or feature source data
SDNM_10year_Waters
Output distance raster
C:\Workspace\SDNM\PublicLandsRCool\Livestock_Use_Prob
Input cost raster (optional)
Fnc_Hill_Slp
Input surface raster (optional)
sdnm_dem_10m
Maximum distance (optional)
Output backlink raster (optional)
Horizontal factor parameters (optional)
Vertical factor parameters (optional)
Source Characteristics
Multiplier to apply to costs (optional)
Double
Field
Cost_Multi
Start cost (optional)
Double
OK
Cancel
Environments...
<< Hide Help
Tool Help
Path Distance
Calculates, for each cell, the least accumulative cost distance to the nearest source, while accounting for surface distance and horizontal and vertical cost factors.


SONORAN DESERT NM
Arizona
Map Location
SDNM Complex
Livestock Use Probability
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
SONORAN DESERT NATIONAL MONUMENT
1:320,000
N
0
2
4
8 Miles
Fencing
Interstates
State Highways
National Monument
Use Classes
Class 1
Class 2
Class 3
Class 4
Class 5

Results

The cell values of the cost surface are interpreted as the shortest distance, around terrain and fence barriers, between a cell and the nearest livestock water location multiplied by the unreliability of the water. Therefore, the values are a function of travel distance for livestock, the characteristics of the livestock waters (use of waters and their reliability) and characteristics of the surface the livestock is traversing. An interpretation of the resulting values is the potential intensity of livestock use – assuming the lower the class, the higher potential use intensity. Table 2 shows the percentage of the study area within each class.

Class	**Cost (distance in meters)**	**Cost (Distance in Miles)**	**Percentage of Study Area**
Class 1	0 to 804.67	0.5	7.1
Class 2	804.68 to 1,609.34	1	13.8
Class 3	1,609.35 to 2,414.02	1.5	13.5
Class 4	2,414.03 to 3,218.69	2	10.9
Class 5	3,218.70 to 91,864.76	2+	54.6

Table 2. Percentage of the study area within each class

Discussion

Areas cattle prefer generally contain resources required to fulfill their life needs and are determined by many factors, but cattle are often restricted due to their limited mobility (Holecheck 1988; Hart et al. 1993; Sheehy & Vavra 1996; Holecheck et al. 2004; Halbritter &Bender 2011). The location of water and salt play a large role in the movement of cattle across a landscape (Ganskopp 2001). In general, livestock do not travel more than 2 miles from water on flat terrain and no more than 1 mile in rough terrain (Smith et al. 1986). Distance from water and slope are two common variables used to predict livestock distribution in almost every environment (Mueggler 1965; Gillen et al. 1984; Halbritter& Bender 2011). Furthermore, range condition is generally related to the distance from livestock water points (Martin and Severson 1988; Blanco et al. 2009). Maps using livestock distribution variables to predict the distribution of livestock impacts can be used to determine if livestock are the causal factor for unsatisfactory range condition observed on the ground. These maps and methods used for this model rely on suitability models to represent characteristics on the landscape (McHarg 1969) and shortest path algorithms (Dijkstra 1959).

The intent of this map is to illustrate the range of livestock grazing probability across the study area and to assist in the determination of whether livestock grazing is the causal factor for the non-achievement of rangeland health standards. The classification of this map is used in conjunction with field based random monitoring plots. Each random monitoring plot falls within one of five use probability classifications where Class 1 represents the highest potential for livestock use and Class 5 the lowest. When a plot fails to achieve a standard for rangeland health is located within Class 1 and there are clear signs of recent livestock use/presence, range managers can reasonably assume livestock grazing is the causal factor for the non-achievement of the standard in question. These determinations should be made with field observations in regards to livestock impacts and utilization monitoring data, if available.

Livestock use probability maps are useful when other information in regards to livestock use are limited. However, these maps contain assumptions that may not explain every variable regarding livestock use probability. These maps assume all waters are used evenly when functional, wells are always functional, forage quality is evenly distributed across the landscape, and all livestock breeds and ages use the landscape in a similar fashion among others. Despite these assumptions, livestock use probability maps are useful tools to assist managers with decision making when utilization data is limited.

Literature Cited

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